A Global Energy Transfer Process of Tsunamigenic Earthquake

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A brief note to the author
1) Educational notes
1958 BSc, Kyoto University
1960 MSc, Kyoto University
1963 DSc-Candidate, Kyoto University
1971 Deng(PhD), Kyoto University
2) Affiliations
1963-1997 Engaged as Educational Staff, Kyoto University
1972- Registered- Kyoto University Alamani
3) Honors in brief
1983 Pros de la Franco-Japonaise Societe des Oceanographie, Tokyo
4) Publications-selected
1994 High-Tides at Typhoons on Contiental and Coastal Zones
1997 Remember TSNAMI Hazards
5) Recent activities-
Refer to the materials in "KURENAI"(Repository, Kyoto University Library)
6) Academic memberships
Electromagnetics Society, Fellow (Cambradge, MA, USA)
Royal meteorological Society, UK, Fellow
European Geoscience Union, EU, Member
American Geophysical Union, Life member

PREFACE

This work is a part of the research project started at Kyoto University in 1960.

In the time period od the dawn of the scientific research, the national project was concentrated for a sustainable national welfare under the background of shortage of food, natural hazards (earthquakes in 1944 and 1946 and the typhoon "Makurazaki") and, the significant undulations of the national opulation.

Under the severe social conditions as suggested above, the scientists in Kyoto University have had moved to join for a direction to take part of the national project.

This work in the scientific fields was started by Professors Shoitiro Hatami and Denzaburo Miyadi. They had started first to solve problems to promote the citizen life with finding a way to stable welfare. Miyadi had to promote his scientific research in the problems in "primary production of planctons in the ocean in order to get fishes for the foods in the citizen life.
As for the problems noted above, it was essential to see the motions of the ocean waters which were closely related to the biological problems. Hayami had to inform a flow patterns on the ocean water motion especially in the coastal zone and continental shelf zone.

Since then, we have spent a half of the last century for the research project in Kyoto University.

This work should be taken as one of the extensive research work.

There have been the researches in seismology, geodesy and plate tectonics on the bases of "dynamics for elastic body or materials" nevertheless it should be considered now to introduce everything of knowledges about what have been developed on elasto-plastic process of the materials.

It should be point out here that the earthquakes on the land and under sea had been applied without any consideration on energy transfer process of any one of fault formations at the event of earthquake without any consideration about what was important the process about yielding of material.

This work is a bold model of research for considering energy transfer process from solid-phase material to fluid-phase (liquid-phase or gas-phase) material.

This is the first step in order to update the existing models for earthquakes and for tsunamis.

The author should wish this work as a key for the advanced research in updating dynamics of earthquake and tsunamis in order to help some proper evaluation.

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A GLOBAL ENERGY TRANSFER PROCESS OF TSUNAMIGENIC EARTHQUAKE

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Abstract
This is aimed to give a key for the scientist to note for a crustal plate creeping process as a trigger of great destructive earthquake accompanied by tsunamis in relation to a possible application of satellite monitoring of positioning on the earth surface. At one of the seismic events, a vector pattern of displacements on the earth crust surface monitored by satellite was quite similar to an outflow pattern of a uniform viscous fluid through a slit to focusing to shot a epicenter of the earthquake. This pattern must be for a visco-elastic or elasto-plastic process. In order to realize this pattern, a model is introduced in a global scope to this problem around the seismic epicenter. As one of the special references, the pattern observed at the seismic event on 11 March 2011 by the Geographic Survey Institute. In this case, it is necessary to consider on the possible energy transfer process in relation to the fault formation and tsunami generation. This process could be seen when it is a process found in the plate conveyed by a sporadic shot of the magma in a global scale.

1 INTRODUCTION

This is a note to aim for the scientists to find a key at promoting their researches on crustal plate creeping process for a trigger of great destructive earthquake tsunamis which can be well detected by an application of satellite monitoring of positioning on the earth surface. A problem is raised for the author's interest in order to have his dynamical understanding at an informed attention about the seismic hazards around the coastal zone in a northwestern part of the Pacific Ocean on 11 March 2011. The author has had to see what factor helps us to realize the physical process of tsunamis generated at the seismic event on that day. The sliding shift of the eastern boundary in a global scale could be helpful for realizing the observed sliding shift which might be the trigger of the great tsunamis hitting the coastal zones facing the Pacific Ocean and the islands in the northern Pacific Ocean. This process could be seen when it is taken as a visco-elastic or elaso-plastic process of the plates in a global scale. A more advanced research could be expected after an application of satellite monitoring for geographical processes.

2 KEY TO SLIDE AND SHIFT OF PLATE

Following to the descriptive note seen as above, the author considers a construction of a simple model which might help to see the event.
A target here is what was effective to illustrate the physical process for realizing the event. The hazardous event of the great tsunami generated by an earthquake undersea simulated with significant ambiguity even after the scientists on the basis of the model for tsunami generated a specified by several seismic parameters in fail.
The author has his concept to introduce a techniques for specifying properties of an interested material in order to illustrate the observed and monitored results of a displacement of the interested plates just around the epicenter of an earthquake generated by not only an elastic deformation but elasto-plastic process up to a breaking

stage in the scope of technology in mechanics of elasto-plastic materials.
By this time, a scaling using a parameter of seismic magnitude as has been introduced after the Japanese seismologist referring the descriptive notices found in the past historical descriptions without any scientific consideration of metric measure for the interested earthquakes only for detected on-land. This is based on the no observed dater about the scaling for the earthquakes undersea accompanied by the destructive tsunamis even in the past, in the time period of the historical age and in the time period after a seismic instrumentation which was introduced.
An idea of "moment magnitude" of each one of the past earthquakes has been introduced for these several ten years instead of simple definition of "magnitude", though there had not been any idea to consider energetics at considering earthquakes.
Some of the scientists had introduced their concept of energetics for the seismic event with tsunamis hit on the coastal zone. Seismologists had been not skilled at considering the material of the plates covering the earth surface. Nevertheless, as for the satellite monitoring and sea floor instrumentations of the recent tsunami earthquakes in the Indian Ocean and in the northwestern Pacific, seems suggesting us to consider the earthquakes in a scope of not only elasticity but elasto-plastic mechanics.
Then, it should be introduced another model developed. Then, it might be seen the key was a global process of the magma under the crusts.
As reminding the volcanic event of Iceland in 2010 on a mid-Atlantic ridge, it can be realized that the main several crusts are generated to spread to form the fresh crust undersea, then, a balance of the forcing power to the couples of the crusts.
For example, the Eurasian plate (EAP) and the North Pacific plate (PCP) must have been contributive under a certain condition to be driven by the motion of the magma just under the crusts.
Exactly speaking, the east part of the Japanese main land had been taken by the seismologists as a part of the North American Plate (NAP) between the Eurasian plate (EAP) and the Pacific plate (PCP).
It is now to promote scientific research on earthquake tsunamis on the basis of a more advanced understanding of the interested process without any other prejudice. For this purpose, the seismologists should learn the interested process much more referring not to the indices specifying the process but the observable factors effective to the process in order to find a key to see and update for our advanced understanding about mechanism of earthquakes and tsunamis.

3 ROTATIONAL PLATES

It should be given here a remark to the two plated produced by the activity of magma forcing to spread the plates on both sides to east and west respectively because the mid-Atlantic ridge has a meridional extent geologically, though it is boldly taken that the these two plates, EAP and PCP meets off the Japanese Islands in the northwestern Pacific, so that the front of PCP moves down to subside under EAP to be the sources of the earthquakes generated in deep (in the range of 40 to 100 km deep from the earth surface) for these one hundred years by the scientists in these seventy years (for example, Nakamura, 1994). It was new geophysical finding though it should be updated on the bases of the new data obtained in geology and geophysics.
The, the movement of the EAP can be tracked when the specific stations located on the surface of the plate by using the satellite monitoring techniques for positioning.
The author tends now an application of satellite monitoring of the interested plates is valuable for promoting the related scientific researches indeed.

4 ACTIVITY OF MID-ATLANTIC RIDGE

As for the activity of the mid-Atlantic ridge, it can be the most latest event which was the volcanic eruption in the Iceland on 14 April 2010. This event strongly affected to traffics and related services in Europe. This volcanic effect is appeared as scatter of the volcanic ash scattering over the main and local air ports to interrupt the flight navigation schedule and to threat of the social activity decaying.
As for energetics of this volcanic event, there must be several reports in the area of the Europe.
This volcanic event was one of the most significant eruptions though the energy release of the activated magma must be simply seen through a vent where the surface of the magma was easily observed by eye-watch in a week after the first eruption, just like the case of the 2010 volcanic eruption in Iceland. Nevertheless, no remark has been given whether the energy of the activated magma was completely released or not. There might be some residual energy remained to be spent for horizontal stresses of the interested plates. When the vent was completely closed by an ice cap in the next cold season by a thick ice plate as a part the glacier, the energy of magma at the vent must forced to transferred in a form of a horizontal stress under the plate. The energy should possibly be transferred to drive the rotating Eurasian plate around the point "R" (at the location of the geomagnetic north-pole position in the coastal zone of Siberia) along the circular arc from Iceland to the epicenter of the 2011 seismic event

5 INTERPLATE SHORTENING ZONE

It is already known that a zone of the inter-plate shortening is exist as that along the extended zone of the mid-Atlantic ridge after landing on the coastal zone just neighbor the point "R" (located near at the position 70^0N, 130^0E). This extended zone get to separate the main land of Japan to two parts, i.e., east and west parts. The point "R" is understood as the center of relative motions of EAP and NAP. There might be some elasto-plastic processes must be happened at the seismic event of a tsunamigenic earthquake so that the author has noted that it is in need to find what is the fact in the interested process.

6 PLATE THRUST COUPLING EFFECT

Looking at what had been found by the observation on the land surface, a point R located in the northern part of Siberia is the center of relative motions of EAP and PCP in seismology and plate tectonics with an understanding of that the zone of inter-plate shortening is inside of EAP.
This zone of interpolate shortening helped us to realize that the tsunamis generated by the several earthquakes off the coastal zone should effectively hit to destructive forces in the coastal zones. At every one of those earthquakes in the Japan Sea, seismic fault was considered to be formed in a form of a thrust as coupling effect to the interested two plates. This means that the zone of interpolate shortening acts as a boundary separating EAP and a tip of the North American plate (NAP) and is taking part of important play at the seismic event of a fault formation to make a tsunamigenic earthquake.

7 PLATE SUBDUCTION AND THRUST

The model for a tsunamigenic earthquake had been developed and accepted as one of the scientific success in geophysical processes though there had been left some ambiguity in

parametric definition of a seismic source model. There are many contributions not introduced in this work.

The observed horizontal dislocations on the earth surface were confirmed to show about 1 to 2 m (ca 5 meters at most) to ESE on the coastal zone pointing to the epicenter at the 2011 earthquake accompanied by tsunamis in the northwestern Pacific (Geographic Survey Institute). The spacial pattern of these dislocations on the crust surface of the Eurasian plate EAP) was quite similar to an outflow pattern of a viscous fluid through a slit.

This dislocation pattern had shown that a elasto-plastic pattern at an strong shot of forcing after an energy transfer by a strong shot forcing with a shear stress from the magna to the plate extension sheet on which the northern part of the Japanese Islands was located.

The magma must effectively transferred the energy to the plate, especially, at the depth of around 4 to 40 km from the crust surface to the horizontal direction of ESE and it was dislocated as much as 31m ESE at the offshore stations (T1 and T2) settled on the sea floor (in the range of 1000m to 4000m deep) off the coast (about 200 km) in the Northwestern Pacific (cf. Tohoku University) and it was dislocated as much as 24m to ESE just several ten kilo-meters south to the stations T1 and T2 (Hydrographic Office of Maritime Safety Agency) on the sea floor.

Nevertheless, there is some doubt of any slip-slide error which must be included in the observed data of the dislocations at the station where each of the monitoring recorders must simply be settled on the sloping sea floor by a technique of setting the recorders by a throwing-down positioning without any fixing function to the sea floor as the plate.

The author tends to take these dislocation observed data as a global effect of a residual energy of 2010 Iceland volcanic eruption to the zone of inter-plate shortening as an extention of the axis of the Atlantic mid-ocean ridge through Iceland and to the front of EAP where the subduction of PCP is seen. Fukushima is about 100 km south of the stations. In addition, it could be taken to be easy to transfer the residual energy from Iceland to the interplate shortening and the front of EAP and PCP.

Before the 2011 event it had been accepted that the Pacific plate PCP had been in a spreading motion at an annual speed of a few centimeters per year westward in a form of the magnetic stripes, though at the 2011 seismic event it was observed the horizontal dislocation of 24 meters or 31 meters at most on the sea floor under the sea surface of 4 km as monitored in a form of a fault formation of the earthquake. The epicenter was estimated as 4 km under the crust surface to which the magma must transfered its energy effectively.

The 2011 seismic event tells us that the energy transferred from the magma was sufficiently beyond the plate's elastic yielding critical condition to make the fault formation as the seismic sources. The seismic sources were estimated referring to the seismic data of the 2011 seismic event undersea (after Japan Meteorological Agency).

The maximum dislocation of 24 m at the 2011 seismic event could be evaluated as the Eurasian plate disturbance if the dislocation was caused by the same mechanics ever seen in the Pacific plate. That is to say, the dislocation of the Eurasian plate along an circular arc (assume the arc length to be boldly evaluated 5×10^6 m for the arc length) from Iceland to the epicenter of the 2011 seismic event.

In order to see what amount of the three dimensional displacement pattern can be realized a simple application of an equivalent elasticity assumed for a segment of the earth surface plate.

Assuming that the arc length S boldly as 5×10^6 m on the Eurasian plate, and that the disturbance ΔS could be taken as an elastic slide, then, a bold measure must give us as that, $\Delta S = [E] \times [S]$ for an assumed nominal Young modulus as $E = 20 \times 10^{-10}$ per the force of the unit Pascal per a unit cross section of the crust. The author takes here that this

$\Delta S=10^{-2}$/Pa for a unit force could be related to the disturbance to S with his bold assumption that the magma's sudden disturbance in a form of a spit shot along the circle arc could be the energy source for the disturbance in the plate driven to activate of making the elastic movement of the Eurasian plate at the depth of about 40 km under the crust surface. Hence, the net displacement of 20 m of the spit shot should be considered as ΔS(EAP), and it must be taken to be more effective at the energy transfer from the underlying magma to the crust covering the earth surface just in the undulating crust zone in the other end of the Atlantic mid-ocean ridge where the new crust is produced.

Under the above assumed effective energy transfer, the EAP horizontal displacement of about 20 m in one day eastward at the seismic event though an annual displacement (about an order of 1 cm) of the magnetic stripes on the PAP westward could be boldly evaluated as $\Delta S(PCP)= -1x10^{-3}$/Pa. Now, the author might introduce a bold evaluation of energy transfer from magma to the two related plates to have an answer that the magma energy transfer could be evaluated by the displacement of each plate edge meeting in the northwestern Pacific.

An evaluation of the measure could tell us that the rate $(-1)/(20x10^{2})$ for (PCP)/(EAP), i.e., the maximum of the force to EAP at the 2011 seismic event might be more than 2000 times of the force ever seen at the magnetic stripe of PCP.

An additional notice should be given here in order to realize what process was closely related at the energy transfer from the crust driven by the magma to the tsunamigenic earthquake.

The author tends to consider a global energy balance at considering the 2011 seismic event in the northwestern Pacific.

The epicenter is found around on the line separating the NAP and PCP just off the main island of Japan. This line could be understood as a convergent line where the two magma flows for conveying the two plates. As stated above, the author introduces to consider the magma's contribution to the EAP on a circle arc from Iceland to the epicenter. Now, it is more reasonable to consider the magma flow convergent just neighbor the epicenter. The observed result shows by the Geograpical Survey Institute (GSI, Japan) supporting what the author tends to introduce a global energy transfer process for the 2011 seismic event.

As the magma as a conductive material in a scope of electromagnetics, there might be an inductive effect in the ionized particles in the atmospheric surface layer. The convergent of the magma flow should have a two dimensional singularity in a scope of a mathematical modeling.

Considering the three dimensional process, the magma's vertical motion should be noticed. A highly concentrated energy under the crust must be enough to break the crust just at the convergent point though the residual energy must be transferred by the down flow of the magma. It is quite similar to viscous fluid flow or water flow around a hydraulic wedge weir gauge under the effect of gravity with a three dimensional pattern to be taken consistent to the pattern of the vertical displacement at the seismic event.

Then, the magma's convergence should be in a strongly high energy concentrated around at a fault formation as the epicenter of the earthquake. It might be accompanied by some kinds of tsunamis as the ocean water layer is above the location of he epicenter where energy release was resulted to form the fault at the epicenter after the crust conveyed by the magma. This means that the elastic crust has got to the yielding critical condition so that it make us easy to realize several local fault formation processes in a scope of elasticity. The magma's convergence is consistent to the great tsunamis energy potential. Then, the tsunami models utilized for the local prediction in practice should be have a renewal in a scope of a global energy transfer process at any one of the tsunamigenic earthquakes.

As for a more detailed mechanism, the bold assumption should be adjusted after a more

advanced research work for a more reasonable form. It should be expected to refer to an advanced research works which would be promoted in the next step.

8 GLOBAL SCALING

With a brief notice noted above, the author has to introduce a model for realizing the great tsunamigenic earthquake, for example, the case of the 2011 East-Japan earthquake which happened at the epicenter off the coast facing the northwestern Pacific after the massive effect of the elasto-plastic process in the coastal zone of the circum-Pacific seismic zone and the chained arc of the geographical trench and the arc isands off the Eurasian plate.
Referring to the past example, a seismic evaluation was given by the model though it was forced to revise repeatedly to get the final evaluation of the seismic magnitude as the level nine in scale. The details must be referred to the final report or the scientific papers which might be appear officially later.
Now, the author tends to consider about the effect of the 2010 Iceland volcanic eruption, i.e., the eruption of thee volcano "Eyjafjajoekull". It was one of the great eruption so that its volcanic ashes caused to an interruption in the flight and transportation services and public activities in the area covering the European Union. In April 2011, it was informed that the volcanic eruptions were observed in the volcanic zone of Grimsvotn in Iceland.
The above noted result forces to the author to notice that there are left the essential problems to be solved in a scope of geophysics after an application of satellite monitoring system. For example, the geodetic positioning should be referred to satellite monitoring on the interested plate surfaces even though the tiny glimpse of the geophysical process can be found by application of satellite monitoring.

9 UPDATE TSUNAMI MODEL

The past seismologist in 1990s introduced a set of parameters defined for specify every one of the earthquakes as the seismic events on land though only for the examples found as the cases of the seismic events on-land in a limited part of the island arc in the northwestern Pacific. This parameters were effective to get into classification of all of the seismic events, nevertheless, no energetic release at each seismic event was considered. Then, the sets of the seismic parameters had been evaluated well.
As for the tsunamis evaluation accompanied by the past earthquakes, the scientist has never found any parametric specifying index.
Some of the seismologists had get to use the seismic parameters instead of tsunami parameters for convenience. It was easy the numeral set for the seismic parameters to take them as if they were equivalent for the cases of the earthquakes generated undersea.
In fact, the scientists have had never direct observation for any set for specifying seismic events undersea except the set of seismographs obtained at the stations onland.
There were no data about the epicenter and fault formation undersea.
One day, the author had found a tsunami model as an application of numerical computation by using an estimated set of seismic parameters for an earthquake in one of the academic publications in the field of "Fluid Mechanics". It was justified as if it was proper to any tsunami model without any consideration of the fault formation process at the earthquake interested by one scientist who was highly evaluated in the field of numerical computation technology. Nevertheless, there was no consideration on the energy transfer process from sea floor to sea water layer above the seismic epicenter of the interested earthquake generated undersea.
The author has had never take it agreeable to use the seismic parameters for any earthquake that is equivalent to the tsunami parameters.

When the set of the tsunami parameters is introduced after some researches for energy transfer process in order to relate the set of seismic parameters and the tsunami parameters, it must be considered whether the tsunami model is properly reproduced in a scope of science.
Now, the author has to notice that the tsunami model should be proper at reproducing the tsunami propagation pattern for practical prediction and for protection project.
It is an urgent problem to update the earthquake parametric model in order to obtain an advanced tsunami model.

10 CONCLUSIONS

In order to have a dynamical understanding of global energy transfer process from the plate to the ocean water layer where tsunamis must be accompanied A specific pattern found as a special displacement at a tsunamigenic earthquake in the area around the epicenter.
The author introduced a note to crustal plate creeping process for a trigger of great destructive earthquake tsunamis. This must be equivalent to a visco-elastic or elasto-plastic process at the seismic event in a specific area in a plate.
A model is introduced for a special reference of the seismic event at the 2011 tsunamigenic earthquake in the northwestern Pacific. Tsunamis may be generated after energy transfer from the solid crust as the Eurasian plate to the sea water layer.
It should be clarify what is observable factor for realizing transfer mechanism from the seismic source to the ocean water layer at generating tsunamis, when any energetics is taken into consideration for finding a trigger at an epicenter.
In order to have an advanced research as the next step, it should be introduced to actively referred to the 3D-data for a pattern of not only horizontal but vertical dislocations of the plate in term of time elapse as a seismic disturbance at positioning site even at a case of the earthquakes generated undersea.

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